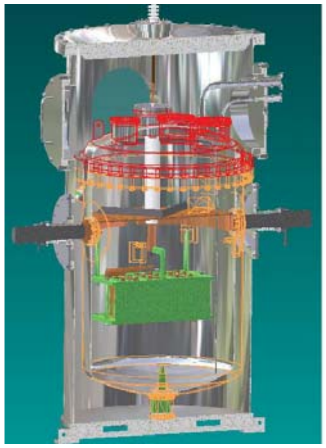
Matrix Fault Current Limiter

Project Fact Sheet

What are its Primary Applications?

The primary application of the High Temperature Superconductivity (HTS) Matrix Fault Current Limiter (MFCL) will be for the reduction of fault current. The device will reduce high levels of fault current to safe levels when installed at strategic locations in transmission and distribution systems, especially for electric utilities and large energy users in high-growth, high density areas.



Scaled low-voltage pre-prototype Matrix Fault Current Limiter (MFCL)

What are the Benefits to Utilities?

The MFCL allows enhanced operating capacity of utility systems. The introduction of new generating facilities and network upgrades can result in fault-current overduty on existing protective equipment. Conventional solutions to fault current over-duty, such as the construction of new substations, splitting existing substation busses, or multiple circuit breaker upgrades, can be very expensive. Conventional copper-based current limiters (i.e. line reactors) can cause voltage instability in the electrical system by adding reactance (a resistance to the flow of current) to the system. This forces the utility to add capacitance to the system to counterbalance the reactive element.

No capacitive correction is needed with the MFCL, since it has no reactance and is passive during non-fault conditions. Utilities can reduce or eliminate the cost of upgrading circuit breakers by installing HTS current limiters. Fault current levels on a typical transformer can be as high as 10 to 20 times the steady state current. One conventional solution to limiting fault current is the use of higher rated circuit breakers. Large capital costs are incurred to not only upgrade the circuit breaker, but also the entire substation buswork. By design, the superconducting MFCL will limit fault current to safe levels so the existing breakers can interrupt the fault current. The MFCL provides improved flexibility in the use of existing lower-rated circuit breakers.

In addition, the new MFCL design will be modular and scaleable to high voltage in a "matrix" configuration. The MFCL consists of individual modules that contain the HTS elements and an inductor connected in parallel that carries the current during faults. The nominal grid current level determines the number of rows of the matrix, and the required current limiting impedance determines the number of columns. This allows the current limiting capabilities to be customized to the user's requirements. This configuration also creates built-in redundancy and improved device reliability.

The MFCL will be transparent, with essentially no losses or voltage drop across the device during normal operation. It will passively detect fault currents and insert current limiting impedance without active monitoring or controls. And it will be safe, with no flammable or environmentally hazardous oil.

What is the Market Potential?

Since fault current limiters are a entirely a new device for grid engineers, hard statistics on the market for the

What is the Status of the Project?

The project is in the first phase of designing, constructing, and testing the proof-of-concept pre-prototype Matrix Fault Current Limiter.

Office of Electric Transmission and Distribution, TD-1
U.S. Department of Energy – 1000 Independence Avenue, SW – Washington, DC 20585

Goal:

To design, fabricate, and test a 138 kV high-temperature superconducting (HTS) Matrix Fault Current Limiter

Team:

SuperPower (team leader)

Nexans SuperConductors (MCP superconductors)

Electric Power Research Institute

Oak Ridge National Laboratory

Technical Advisory Board: (see inset)

Period of Performance:

4 years: 2003 – 2007

Project funding was awarded in 2003

Project will conclude in February 2007

Total Project Funding:

Private $6.0 million

DOE $6.0 million

Total $12.0 million

What is it?

A fault current limiter is designed to react to and reduce unanticipated power disturbances in the utility grid, preventing loss of power to consumers or damage to utility grid equipment.

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devices are not easily available. However, surveys of utilities have identified fault current limiters as the most desired new device technology for U.S grids. Estimates have suggested that significant cost savings and operational benefits of current limiters will create a potential domestic market of several billion dollars in the next 15 years.

What are the Project Accomplishments to Date?

The project was awarded in 2003. The project is divided into three major tasks, the "Pre-prototype," the "Alpha prototype," and the "Beta prototype." Each of these prototypes will demonstrate progressively higher ratings, and are scheduled for completion in 2004, 2005, and 2006 respectively. The Pre-prototype and the Alpha prototype will be tested in a lab setting, while the Beta prototype will be tested on the 138 kV transmission grid at a utility host site.

The project is currently in the test phase for the Pre-prototype, proof-of-concept device. SuperPower has decided that the MFCL will use Nexans' Melt Cast Processed BSCCO-2212 superconductors.

How Does it Work?

Fault currents are caused by lightning, downed trees, and downed utility poles. These events send a surge of power through the grid that can cause serious damage to grid equipment, and as a result, the system's circuit breakers shut down the affected part of the system. Serious faults can generate surge currents more than one hundred times the normal operating current. Severe faults can cause electricity to arc uncontrollably within the breaker, rendering the breaker ineffective. Extensive damage to utility or customer equipment may result. The operating life of a circuit breaker is also diminished by the number and severity of faults it experiences. The MFCL, when installed on the grid, can detect a power surge and safely reduce the fault current, and will allow existing circuit breakers to isolate the fault. This device limits the impact of a fault current, ensuring uninterrupted power supply to the grid's customers and protecting expensive utility equipment. The MFCL is the first such device designed for transmission voltages, with the initial target for operation at 138kV.

Technical Advisory Board:

American Electric Power

Argonne National Laboratory

Con Edison

Florida State University – CAPS

Los Alamos National Laboratory

National Electrical Energy Testing Research and Applications Center (NEETRAC)

New York Power Authority

Rensselaer Polytechnic Institute

Southern California Edison

Tennessee Valley Authority

Alignment with Administration Priorities:

National Energy Policy: " …expand the Department's research and development on transmission reliability and superconductivity"

National Transmission Grid Study: " … accelerate development and demonstration of its technologies, including high-temperature superconductivity…

Secretary of Energy: "… focuses R&D dollars on long-term, potentially high-payoff activities that require Federal involvement to be both successful and achieve public benefit."

Energy Information Administration: "of [advanced power delivery] technologies, superconductivity holds the most promise for yielding significant efficiency gains."